Model 459
5 kV Detector Bias Supply
Operating and Service Manual

This manual applies to instruments marked
"Rev 21" on rear panel

Rev Level 2V
No Manual Change

Printed in U.S.A.

2811 3.5C 0778

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DAMAGE IN TRANSIT

Shipments should be examined immediately upon receipt for evidence of external or concealed damage. The carrier making delivery should be notified immediately of any such damage, since the carrier is normally liable for damage in shipment. Packing materials, waybills, and other such documentation should be preserved in order to establish claims. After such notification to the carrier, please notify EG&G ORTEC of the circumstances so that assistance can be provided in making damage claims and in providing replacement equipment if necessary.

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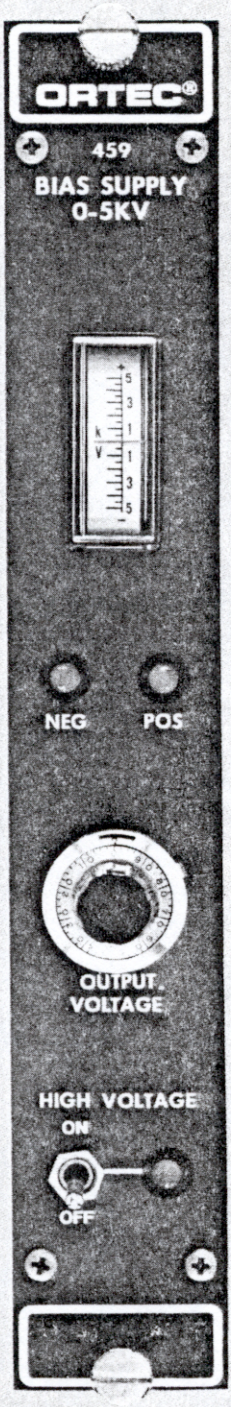
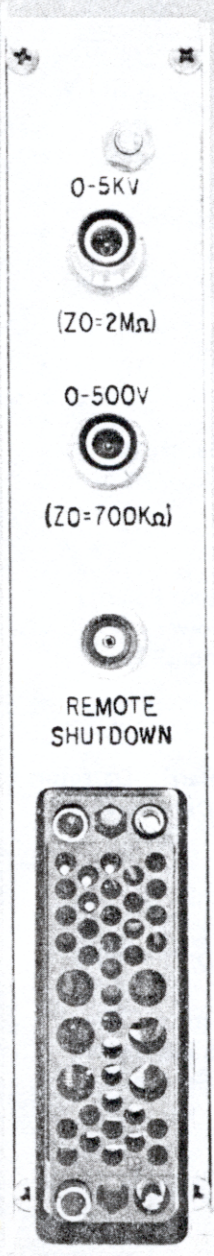

ORTEC®
459
BIAS SUPPLY
0-5KV
NEG
POS
OUTPUT
VOLTAGE
HIGH VOLTAGE
ON
OFF


0-5KV
(ZO=2MΩ)
0-500V
(ZO=700KΩ)
REMOTE
SHUTDOWN

ORTEC 459 5KV DETECTOR BIAS SUPPLY

1. DESCRIPTION

The ORTEC 459 0–5 kV Detector Bias Supply provides a bias voltage of either polarity for a semiconductor detector or for a very low current voltage divider in a photomultiplier tube and scintillation detector assembly. Two outputs are provided simultaneously: one for a range of 0 to 5 kV for high voltage requirements and one for a range of 0 to 500 V for lower voltage detectors. Both output voltages are adjusted by a 5-turn direct-reading control for a potentiometer located on the front panel.

Either polarity is available through both outputs. The polarity is selected by the orientation of a plug-in printed circuit that can be attached to the main board in either of two positions. The selected polarity is indicated by a light, Neg or Pos, on the front panel. A front panel meter also indicates the selected polarity and the approximate voltage available through the 5-kV output; the 500-V output automatically provides 10% of the level through the 5-kV output.

The Detector Bias Supply receives its required operating power from an ORTEC 401A/402A Bin and Power Supply in which it is installed for operation. All of the input power is supplied through the rear panel module connector.

2. SPECIFICATIONS

2.1. PERFORMANCE

Bias Voltage Outputs Two output circuits, ranges 0 to 5 kV and 0 to 500 V.

Bias Control 5-turn direct-reading precision potentiometer.

Bias Polarity Either positive or negative for both outputs (both outputs same polarity), selected by internal switch and indicated on front panel.

Noise and Ripple <10 mV peak to peak from 2 Hz to 50 MHz.

Temperature Stability 0.02%/°C through 0 to 50°C operating range.

Voltage Stability <0.1%/hr variation in output voltage with constant input voltages from Bin supply, constant temperature, and constant load.

Output Current 0 to 100 μA.

Output Linearity Within ±3% of dial setting from 10% to full range.

2.2. CONTROLS

Output Voltage 5-turn direct-reading potentiometer with 500 dial divisions, adjusts the output levels for both the 5-kV and 500-V outputs simultaneously.

High Voltage On/Off Toggle switch and indicator lamp show when the instrument circuits are turned on to provide an output. The lamp turns off when the remote shutdown circuit is grounded and high voltage is not available.

Polarity +/– Internal plug board selects either polarity for both outputs, and front panel indicators show which has been selected.

2.3. INPUTS

Power All input power is furnished through the rear panel module connector.

Remote Shutdown Rear panel BNC connector; shorting the center contact to ground reduces the output voltage to zero (Z_{max} of grounding circuit, < 1 kΩ).

2.4. OUTPUTS

0-5KV (Z_o = 2 MΩ) Rear panel SHV connector furnishes the adjusted output voltage in the 0- to 5-kV range through an output impedance of approximately 2 MΩ.

0-500V (Z_o = 700 kΩ) Rear panel SHV connector furnishes the adjusted output voltage in the 0- to 500-V range through an output impedance of approximately 700 kΩ.

2.5. ELECTRICAL AND MECHANICAL

Power Required for Maximum Load

+24 V, 80 mA; +12 V, 12 mA;
−24 V, 65 mA; −12 V, 0 mA.

Dimensions Standard single-width NIM module (1.35 by 8.714 in.) per TID-20893.

3. INSTALLATION

3.1. GENERAL

The Detector Bias Supply is normally used in conjunction with other modular electronics and is installed in a 401A/402A Bin and Power Supply. The Bin and Power Supply is intended for rack mounting. Therefore any other equipment that may be installed in the same rack must be sufficiently cooled by circulating air to prevent any localized heating in the circuits in the 459. The temperature of equipment operating in racks can easily exceed the recommended maximum of 50°C (120°F) unless these precautions are taken.

3.2. SELECTION OF OUTPUT POLARITY

The polarity of the output voltage of the 459 is determined by the location of a rectangular plug board on the main printed circuit. Access to the plug board is obtained by removing the left side panel of the module (viewed from the front). Its two alternate locations are marked on the main printed circuit.

3.3. CONNECTION TO POWER

This instrument obtains its dc operating power from the standard Bin and Power Supply in which it is installed. Always turn off power for both the Bin Power Supply and the 459 before inserting or removing the module. When the Bin and Power Supply switch is then turned on, the polarity selection will be indicated on the 459 before high voltage is actually furnished from its output connectors. The adjusted high voltage is then available through the output connectors as soon as the 459 high-voltage switch is turned on.

3.4. OUTPUT CONNECTIONS

The Detector Bias Supply is compatible with all ORTEC preamplifiers that include provisions to accept the high voltage for the detector. The output controls are located on the front panel, and the output connectors are located on the rear panel. The output cables will require a type SHV connector at the power supply end, which is the type furnished with each ORTEC preamplifier for this purpose.

4. OPERATION

CAUTION

Always have the high voltage turned off before connecting the cable to or disconnecting it from the preamplifier.

After the high voltage is turned on, allow approximately 30 min for high-voltage stressing of the capacitor to subside before attempting to take data with high-resolution systems.

4.1. SILICON SURFACE-BARRIER DETECTORS

Operating bias voltage for a silicon surface-barrier detector should not be applied as a large step, but should be advanced gradually from zero up to the recommended operating potential. With the 459, set the front-panel control at zero before switching on the power. Then gradually advance the setting of the 5-turn potentiometer to the recommended level for the detector.

To remove the detector bias, reduce the setting of the 5-turn control to zero at the 459 while the output cable is still connected to the preamplifier.

4.2. OTHER TYPES OF DETECTORS

Operating bias for germanium or scintillation detectors can be applied as a step from zero to the full operating value. For these applications the 5-turn potentiometer can be

adjusted to the required output voltage level while the power switch is turned off, and then power can be applied by simply turning on the power with the high-voltage switch.

4.3. LOADING EFFECTS

The actual output voltage depends on the current that is drawn from the 459 by its external circuit. To determine the actual voltage at the "0-5 KV" connector, consider the amount of voltage drop in the 2-MΩ series output resistance, which will be a function of the output current. The output voltage can be calculated with the formula

$$V_o = V_{dial} - I(2 \times 10^6),$$

where

V_o = output voltage,
V_{dial} = setting indicated by 5-turn control,
I = output current in amperes.

If the output current is expressed in microamperes, the formula is simplified to

$$V_o = V_{dial} - 2I.$$

For example, if I = 50 μA and the V_{dial} setting is at maximum for 5000 V, $V_o = 5000 - 2(50) = 4900$ V.

The actual output voltage at the "0-500 V" connector can be found in a similar manner by considering the approximately 700 kΩ output resistance. The formula will then be

$$V_o = V_{dial} - I(7 \times 10^5),$$

where the definitions are the same as before.

To find the actual voltage applied to a detector, the resistance between the 459 output and the detector itself must be identified. Since the bias voltage is usually connected through a load resistor in the preamplifier and then to the detector, the resistance can usually be identified from the preamplifier schematic. The actual detector voltage can then be found with the formula

$$V_d = V_o - I_d R,$$

where V_d is the detector voltage, V_o is the 459 output voltage, I_d is the detector current, and R is the series resistance between the 459 and the detector.

5. CIRCUIT DESCRIPTION

The 459 uses a dc-to-dc converter to charge a Cockcroft-Walton[1] multiplier circuit. The primary of the transformer is driven from an astable multivibrator operating at approximately 20 kHz. Transistors Q1 and Q2 form the multivibrator circuit, while Q3 through Q6 serve as drivers and switching transistors for transformer T1.

The output voltage is adjusted by controlling the voltage applied to the primary of the transformer. Resistor R23 controls the primary voltage through transistors Q7 and Q8.

The circuitry in the transformer secondary consists of a 7-stage Cockcroft-Walton multiplier circuit. Polarity selection is made with a plug-in board that completes the necessary circuits for either polarity by its orientation on the main printed circuit. In schematic 459-0101-S1 at the back of this manual the alternate circuit connections are shown as sections of a double-throw switch, S2. For polarity reversal the input and output terminals of the Cockcroft-Walton circuit are interchanged. The 0–500 V is taken from the first stage of the multiplier circuit so that this output will always have the same polarity as the 0–5 kV output.

The output voltage can be adjusted with trim potentiometer R22. This adjustment should be made with an insulated screwdriver through one of the holes in the top cover. The calibration of the front panel meter is made with trim potentiometer R40, and this adjustment is also available through one of the holes in the top cover. The meter is intended as an approximate indication of the output voltage, and also shows the polarity of the output.

If the remote shutdown circuit is used, it will clamp the output voltage through both of the 459 output circuits to zero when the external circuit grounds the center contact of the BNC connector with 1000Ω impedance or less. This turns on both Q10 and Q11. With Q10 turned on, Q7 and Q8 cannot furnish any reference drive to the primary of transformer T1 and high voltage cannot be generated. With Q11 turned on, Q12 is turned off and the front panel HV On indicator will not light.

[1] Everhart and Lorrain, "The Cockcroft-Walton Voltage Multiplying Circuit," *Rev. Sci. Instr.* **24**(3), 221 (1953).

6. MAINTENANCE AND TESTING

CAUTION

THE HIGH VOLTAGES THAT ARE PRESENT IN THIS INSTRUMENT ARE HAZARDOUS. DO NOT ATTEMPT ANY ADJUSTMENTS OR MAINTENANCE UNLESS YOU ARE EXPERIENCED IN HANDLING HIGH-VOLTAGE CIRCUITS.

Test Equipment Required:

Nuclear Standard Bin and Power Supply such as ORTEC 401A/402A
Oscilloscope with sensitivity of 10 mV or better
Voltmeter with input impedance of 100 MΩ or more on 5000-V range
Schematic diagram of the 459 Detector Bias Supply

6.1. PERFORMANCE TESTS

1. Install the 459 in the 401A/402A Bin and Power Supply.

2. Leave the High Voltage switch set at Off and connect the 0-5 KV output to the voltmeter, set for a 5000-V range.

3. Set the High Voltage switch at On and increase the 5-turn control slowly to maximum for 5000 V. Consider the loading effect of the voltmeter on the high-voltage supply and observe the output voltage. For example, a voltmeter with a 100-MΩ input impedance will have a 50-μA current at full scale. This will cause a 100-V drop across the 2-MΩ internal resistance in the power supply and the meter will read only 4900 V maximum.

4. Return the output voltage control to zero and check the potentiometer linearity by comparing the output voltages to dial readings at several points.

5. To check ripple and noise it is necessary to place a capacitor that will withstand 5000 V in series with the 0-5 KV output of the 459 and to connect this to an oscilloscope. Set the oscilloscope for a dc input and the lowest available sensitivity until the Detector Bias Supply output has been increased slowly to 5000 V. Then the oscilloscope sensitivity can be increased to observe the ripple and noise, which should not exceed 10 mV.

6.2. TROUBLESHOOTING SUGGESTIONS

1. Ensure that the proper dc input voltage is being supplied to the 459. It requires +24 V, −24 V, +12 V, and −12 V.

2. With an oscilloscope, check carefully for a square wave at the collectors of Q1 and Q2. If no square wave is present, replace the transistors Q1 and Q2.

3. Check for a square wave at the collectors of Q5 and Q6. This square wave should vary in amplitude with the setting of the output voltage control. If no variation is seen, check Q7 and Q8.

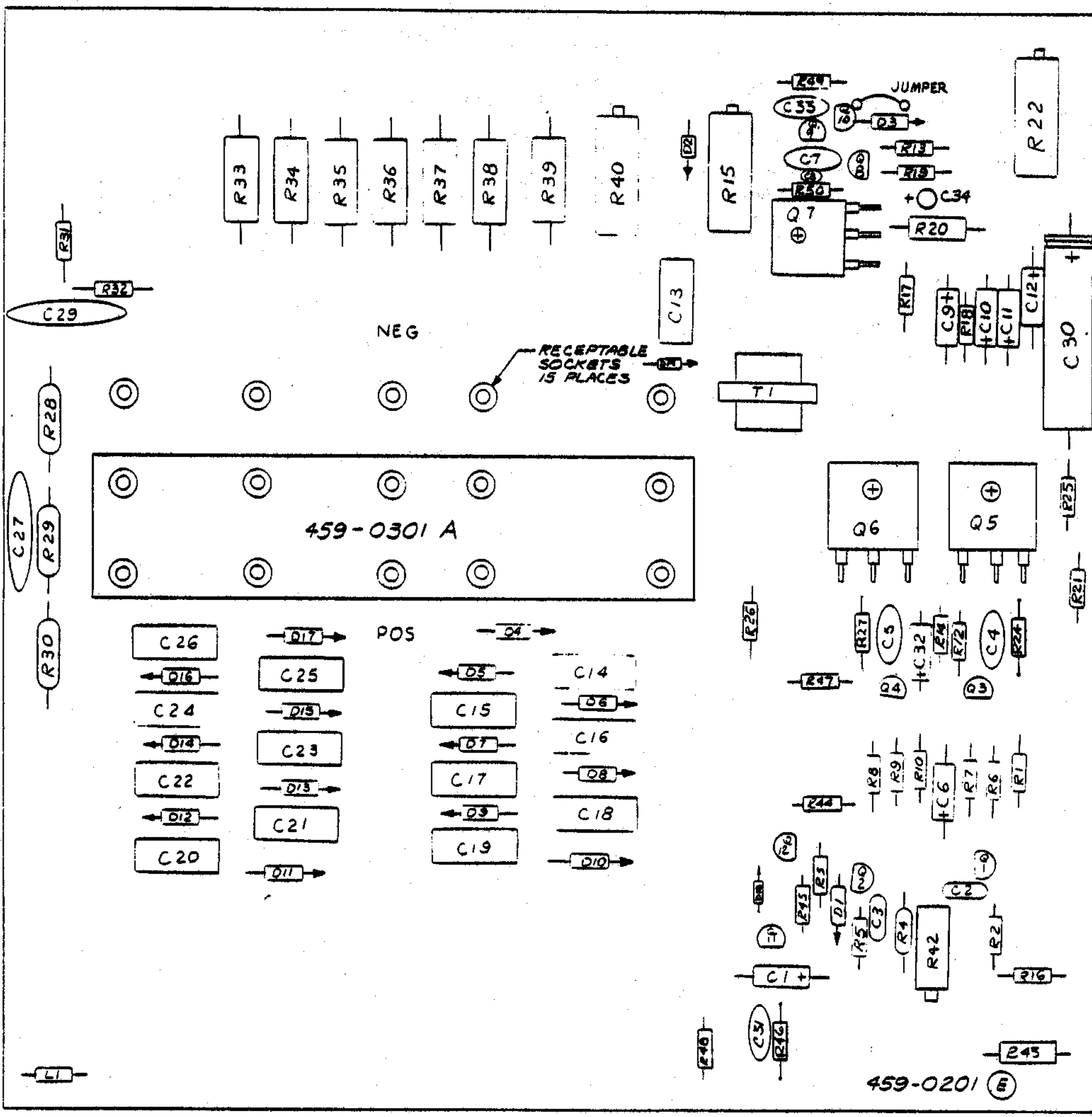
6.3. FACTORY REPAIR SERVICE

This instrument can be returned to the ORTEC factory for service and repair at a nominal cost. Our standard procedure for repair ensures the same quality control and checkout that are used for a new instrument. Always contact Customer Services at ORTEC, (615) 482-4411, before sending in an instrument for repair to obtain shipping instructions and so that the required Return Authorization Number can be assigned to the unit. Write this number on the address label and on the package to ensure prompt attention when it reaches the ORTEC factory.

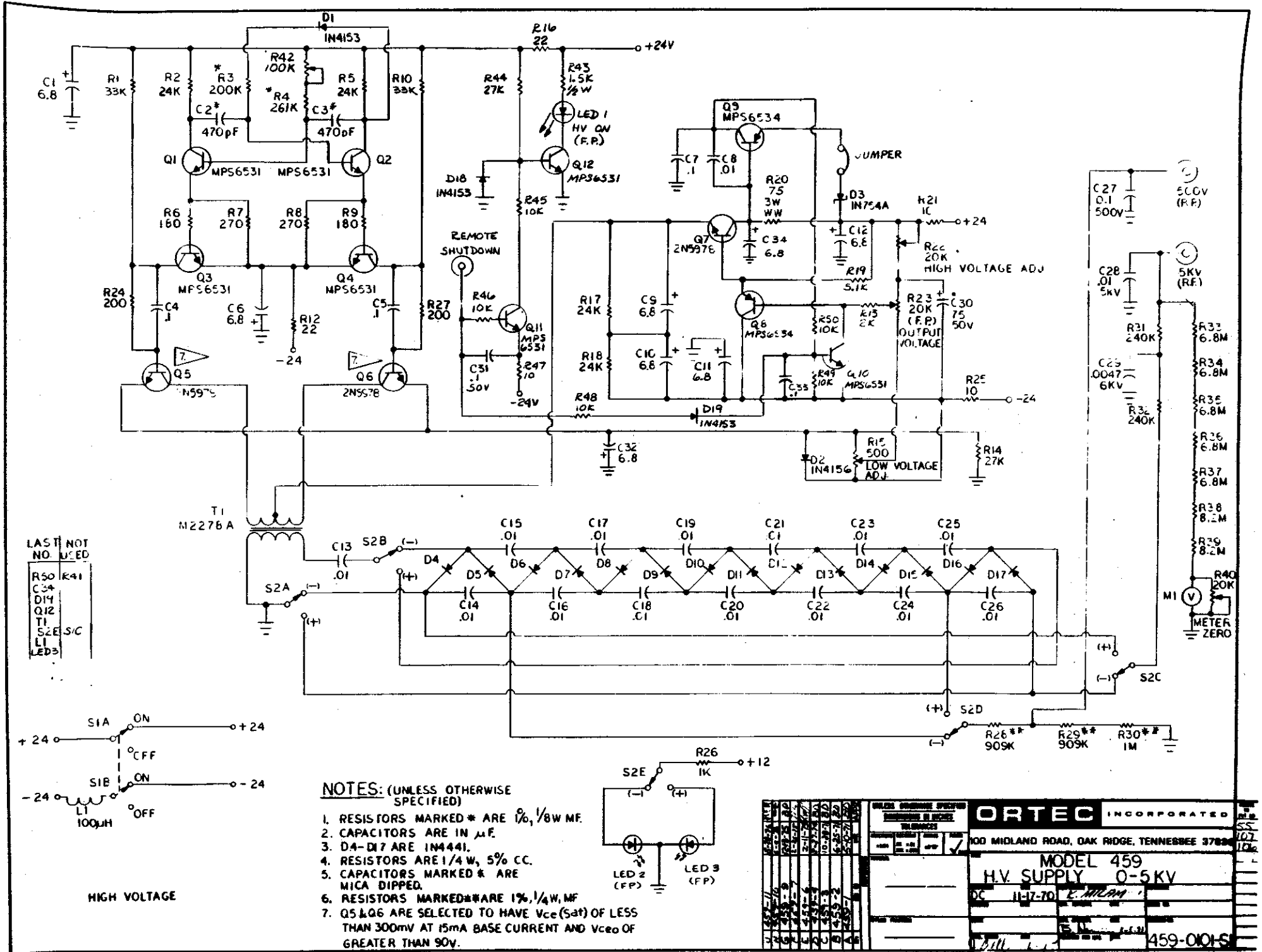
BIN/MODULE CONNECTOR PIN ASSIGNMENTS FOR AEC STANDARD NUCLEAR INSTRUMENT MODULES PER TID-20893

Pin	Function	Pin	Function
1	+3 volts	23	Reserved
2	−3 volts	24	Reserved
3	Spare Bus	25	Reserved
4	Reserved Bus	26	Spare
5	Coaxial	27	Spare
6	Coaxial	*28	+24 volts
7	Coaxial	*29	−24 volts
8	200 volts dc	30	Spare Bus
9	Spare	31	Spare
*10	+6 volts	32	Spare
*11	−6 volts	*33	115 volts ac (Hot)
12	Reserved Bus	*34	Power Return Ground
13	Spare	**35	Reset (Scaler)
14	Spare	**36	Gate
15	Reserved	**37	Reset (Auxiliary)
*16	+12 volts	38	Coaxial
*17	−12 volts	39	Coaxial
18	Spare Bus	40	Coaxial
19	Reserved Bus	*41	115 volts ac (Neut.)
20	Spare	*42	High Quality Ground
21	Spare	G	Ground Guide Pin
22	Reserved		

Pins marked (*) are installed and wired in ORTEC 401A and 401B Modular System Bins.
Pins marked (*) and (**) are installed and wired in EG&G/ORTEC–HEP M250/N and M350/N NIMBINS.



JUMPER
R49
C33
D3
R13
R19
C7
R50
C34
R22
R33
R34
R35
R36
R37
R38
R39
R40
D2
R15
Q7
R20
R31
R32
C29
C13
R17
C9
R18
C10
C11
C12
C30
NEG
RECEPTABLE SOCKETS 15 PLACES
T1
R28
459-0301 A
Q6
Q5
R25
C27
R29
R21
R30
R26
R27
C5
C32
R11
R12
C4
R24
POS
D4
C26
D17
C25
D16
D5
C14
C24
D15
C15
D6
R47
Q4
Q3
D14
C23
D7
C16
C22
D13
C17
D8
R8
R9
R10
C6
R7
R6
R1
R44
D12
C21
D9
C18
C20
C19
D11
D10
R3
R45
D1
C3
C2
R5
R4
R42
R2
C1
R16
C31
R46
R48
R43
L1
459-0201 E



NOTES: (UNLESS OTHERWISE SPECIFIED)

1. RESISTORS MARKED * ARE 1%, 1/8W MF.
2. CAPACITORS ARE IN μF.
3. D4-D17 ARE IN4441.
4. RESISTORS ARE 1/4 W, 5% CC.
5. CAPACITORS MARKED * ARE MICA DIPPED.
6. RESISTORS MARKED** ARE 1%, 1/4W, MF
7. Q5 & Q6 ARE SELECTED TO HAVE Vce (Sat) OF LESS THAN 300mV AT 15mA BASE CURRENT AND Vceo OF GREATER THAN 90V.

ORTEC INCORPORATED

100 MIDLAND ROAD, OAK RIDGE, TENNESSEE 37830

MODEL 459
H.V. SUPPLY 0-5 KV

DC 11-17-70 E. Mraz

459-0101-S

RFD. 70-1129